Candidates who live at places remote from St. Louis, and who wish to be spared the expense of coming to the city for examination, may send, with their application, the name and address of the principal of the nearest high school, or of some approved private school, in case he is willing to take charge of such examination for them; but all applications of this character must be in the hands of the Director not later than the middle of February. If the examiner is approved, papers will be sent to him before the date set for the examination, and on the payment of a fee of 2 dollars to him, the candidate may write on them in his presence. If competitive examinations are also required, the same examiner will receive the papers for them in time to submit them to the candidate on the date set for similar examinations in St. Louis, on receipt of an additional fee of 3 dollars as a partial payment for his time in conducting the examination. The papers written on such examinations will be forwarded by the examiner to the Director, who will read them in connection with those written in St. Louis, before making any awards.

Successful candidates will be started in their duties as garden pupils on Tuesday, March 31, at the Botanical Garden. They will be lodged in comfortable rooms in a spacious dwelling adjoining the Garden under the charge of the head gardener, or some other competent person. It is not the intention of the Trustees to furnish table board, but good board can be obtained in the lodging-house or elsewhere at the usual cost. The lodging-house includes a reading-room supplied with the more valuable horticultural and agricultural papers, and also with a small but standard collection of books on the same subjects, which the pupils have free use of. So far as possible, the surroundings of pupils are made home-like, and, without assuming any responsibility for their behaviour, an effort is made to subject them to influences calculated to insure for them gentlemanly manners and habits of industry and investigation.

During the first year of their scholarship, garden pupils will work at the practical duties of the Garden nine or ten hours daily, according to the season, the same as regular *employés* of the Garden, and will also be expected to read the notes and articles referring to the subject of their work in one or more good journals.

In the second year, in addition to five hours' daily work of the same sort, they will be given instruction and will be required to do thorough reading in vegetable gardening, flower gardening, small-fruit culture, and orchard culture, besides keeping the run of the current papers.

In the third year, in addition to five hours of daily labour, they will be instructed and given reading in forestry, elementary botany, landscape gardening, and the rudiments of surveying and draining, and will be required to take charge of clipping or indexing some department of the current gardening papers for the benefit of all.

In the fourth year, besides the customary work, they will study the botany of weeds, garden vegetables, and fruits, in addition to assisting in the necessary indexing or clipping of papers, &c., and will be taught simple book-keeping, and the legal forms for leases, deeds, &c.

The course for the fifth year, in addition to the customary work, will include the study of vegetable physiology, economic entomology, and fungi, especially those which cause diseases of cultivated plants; and each pupil will be expected to keep a simple set of accounts pertaining to some department of the Garden.

In the sixth year, in addition to the manual work, pupils will study the botany of garden and green-house plants, of ferns, and of trees in their winter condition, besides the theoretical part of special gardening, connected with some branch of the work that they are charged with in the Garden.

From time to time changes in this course will be made, as they shall appear to be desirable, and the effort will be made to give the best theoretical instruction possible in the various subjects prescribed; but it is not intended to make botanists or other scientific specialists of garden pupils, but, on the contrary, practical gardeners.

Applications for scholarships, and any inquiries regarding them, are to be addressed as below, on or before the dates mentioned above. If requested, blanks will be mailed to persons who contemplate making application.

WILLIAM TRELEASE,
Director of the Missouri Botanical Garden.
St. Louis, Mo.

WASHINGTON OBSERVATIONS, APPENDIX I.

THIS volume consists of reports, to the Superintendent, of the Transactions of the International Astrophotographic Congress, and of "A Visit to certain European Observatories and other Institutions," by Albert G. Winterhalter.

In the first report will be found a good detailed account of the most important points that have been discussed in order to obtain the best and most accurate methods by which a chart of the heavens may be made. Among the resolutions that were passed at this Congress, the following may be mentioned:—Refractors shall be used exclusively, the object-glasses of which shall have apertures of 33 centimetres and focal lengths of about 3·43 metres. The aplanatism and achromatism of these glasses shall be calculated for the wave-lengths near the Fraunhofer line G, by which means use may be made of the maximum of sensitiveness of the photographic plates. All the plates will be prepared from a single formula, and as regards their sensitiveness a permanent control will be instituted. In order to eliminate defects in the plates, two series of photographs of the whole sky will be made, and so arranged that stars on the edges of one will be more or less central on the other. In addition to the above-mentioned series of plates, another will be taken with shorter exposures, so as to obtain greater precision in the micrometric measurement of the fundamental stars, and to make possible the formation of a catalogue. The author, in his general conclusions at the end of this report, points out the necessity for a mutual dependence and relation of all workers in astronomy, and he adds, "The necessity becomes urgent in the light of the late development and the multiplying branches of that science. Had there been no practical results of the international reunion at Paris, there would still have remained much good derived from personal acquaintance and discussion."

The second part of the work forms a most valuable record of the instruments that are employed in most of the chief Observatories of to-day. The author made the visits in obedience to orders of the Department and of the Superintendent that were issued to him, all of which he has appended in the latter end of Part IV. To give an account of the various Observatories described in this volume, or even to summarize the information recorded, would occupy too much space, so that we will restrict ourselves to the visit paid to England, and make some brief extracts relating to the Observatories mentioned.

Of course, the first Observatory visited was that of Greenwich, and the author does not give such a detailed account of it as he does of many others, as "no observatory is more intimately known to Americans. This is largely due to the thoroughness with which the parts have been described from time to time, and to the frequency with which the establishment has been referred to as a model in one or the other particular." At any rate, he gives a good description of most of the chief instruments employed, with details of their construction; he also paid great attention to the various styles of domes employed, and the means adopted for rotating them. The photoheliograph is described, also the magnetical and meteorological instruments, and a brief account is given of the chronometer, time signals, clocks, and chronographs.

The next Observatories visited were those of Kew, Huggins's, and Common's; during the author's stay at the last-named Observatory the 5-foot mirror was in progress of rough polish. He also briefly states the means that were going to be adopted for floating the axis, the tube of which would measure 8 feet in diameter, so that its ends would then only have to be confined to the extremities of the tank by pins.

The visits of the author not being strictly confined to Observatories, he went over the workshops of Troughton and Simms, that are situated at Charlton, in which he saw instruments of all kinds in course of construction. As a typical example of the work turned out he takes the transit-circle with an object-glass of 8 inches and a focal length of 9 feet, an illustration of which is given.

The last English Observatories visited were those of Oxford and Cambridge, and after some short historical notes, the various instruments in each are described in detail.

Part III. consists of reports on sundry astronomical and nautical constructions and processes, and amongst the subjects treated may be mentioned the following: the construction of the great dome at Nice, M. Bigourdan's apparatus for determining the personal equation in double-star measurements, various forms of artificial horizons, a new level-trier, public time-service, and the equatorial coudé.

© 1890 Nature Publishing Group

In Part IV. the author relates a few very general conclusions that he has arrived at after his series of visits, some of which we will state quite briefly. Each prominent instrument should have its own building; dwellings for observers should be on the premises; good workshops should be provided, so that repairs may be done on the spot; and electricity should be used throughout. Copies of the orders from the Navy Department follow next in order; and the volume terminates with a list of books, photographs, &c., that were bought at the various places visited.

The work as a whole supplies the reader with an excellent and trustworthy description of many of the chief Observatories of the present day; it may be stated, however, that the author has deemed it necessary to omit a large amount of information on methods, instruments, &c., his reason for so doing being that it will be found in other publications.

The illustrations throughout add greatly to the value of the book, and the American Government ought to be congratulated on the result of the work.

FIELD EXPERIMENTS AT ROTHAMSTED.[1]

THESE memoranda are issued yearly, in order to bring the results of the field experiments up to the present time. The matter is closely condensed, most of the information being in the form of schedules and tables. The results include observations and experiments upon rainfall, drainage, composition of drainage water, disposal of rainfall through percolation and evaporation, as well as upon the effects of artificial manures on various crops, most of which have been grown upon the same land, under strictly regulated conditions, for forty years. To those who are accustomed to follow the results obtained at Rothamsted, there is nothing novel in those portions of the memoranda, as they merely contain the account of a work with which the agricultural public is familiar. No one not already aware of the elaborate nature of the Rothamsted experiments can take up these memoranda without being struck with the vast amount of labour, patience, expenditure, and ability disclosed. Agriculturists will probably be disposed to confine their attention to the effects of fertilizers upon certain crops, but after perusing this interesting document we come to the conclusion that the Rothamsted observations reach much further in their significance than the limits of agricultural practice. They must assist in the solution of physiological questions involving both animals and vegetables, and physical questions relating to the gradual changes wrought upon the surface of the earth through rainfall and atmospheric action. The Rothamsted results, carefully tabulated year by year, contain a mass of data from which important conclusions may be drawn. Among these data we note—(1) Observations upon the determination of nitrogen as ammonia, as nitric acid, and as organic nitrogen, and also some other constituents, in many samples both of the rain and of the various drainage waters collected at Rothamsted. It is only by such observations that any idea can be formed as to the sources of the nitrogen of growing plants. We have here a means for estimating both the amount of nitrogen brought down in rain and wasted through drainage—two factors which must be kept in view when the relations of plants to combined nitrogen at present existing in the soil are to be investigated. (2) Observations on the difference in the character and amount of the constituents assimilated by plants of different botanical relationships, under equal external conditions, or by the same description of plants under varying conditions. (3) Observations on the character and range of the roots of different plants, and on their relative development of stem, leaf, &c. (4) Observations on the composition of the entire plant, and various parts of the same plants, at different stages of growth.

One of the most important subjects, which has acquired fresh interest at the present time, is that of the assimilation of free nitrogen by growing plants. In treating of this deeply interesting question Sir John Lawes says:—"In recent years this question has assumed quite a new aspect. It now is, whether the free nitrogen of the atmosphere is brought into combination under the influence of micro-organisms or other low forms, either within the soil or in symbiosis with a higher plant, thus serving indirectly as a source of nitrogen to plants of a higher order. Considering that the results of Hellriegel and Wilfarth on this point were, if confirmed, of great significance and importance, . . . a preliminary series (of experiments) was undertaken in 1888, a more extended one was conducted in 1889, and the subject is being further investigated in the present year. The results so far obtained show that, when a soil growing leguminous plants is infected with appropriate organisms, there is a development of the so-called leguminous nodules on the roots of the plants, and, coincidently, increased growth and gain of nitrogen. These results were obtained after adding to a sterilized sandy soil growing leguminous plants a small quantity of the watery extract of a soil containing the appropriate organisms. There is no evidence that the leguminous plant itself assimilates free nitrogen; the supposition is rather that the gain is due to the fixation of nitrogen in the growth of the lower organisms in the root nodules, the nitrogenous compounds so produced being taken up and utilized by the leguminous plants. It would seem, therefore, that in the growth of leguminous plants, such as clover, vetches, peas, beans, lucerne, &c., at any rate some of the large amount of nitrogen which they contain may be due to atmospheric nitrogen brought into combination by the agency of lower organisms." No hint is given as to the identity of the "lower organism" so frequently mentioned, but there is reason to think that it is a fungus belonging to the class *Ustilaginæ*, which exists in and is the cause of the tubercles, or root nodules, found upon the root fibres of leguminous plants.

The bulk of the memorandum is occupied with the continuation and re-editing up to date of the results obtained at Rothamsted by the application of fertilizers. The matter is important, but as it takes the form of an annual report in which the latest results are added to and incorporated with those of previous years, already noticed by us in due course, we must refrain at the present time from more lengthy notice. Sir John Lawes has always been a stout advocate of the view that the source of nitrogen in plants was to be looked for *in the soil* and not in the air. It is, therefore, an interesting fact, as between him and the believers in the assimilation of atmospheric free nitrogen, that the micro-organisms in question seem to offer a *modus vivendi*, or means of reconciliation, between two hitherto conflicting doctrines.

SCIENTIFIC SERIALS.

IN the *American Meteorological Journal* for November, Prof. W. Ferrel replies to the attacks made by Prof. Hazen on Espy's experiments on storm generation. He points out that this theory does not rest upon the experiments of Espy alone, but on those of Regnault, Clausius, Sir W. Thomson, and others, all of which were finally embraced in a convenient formula by Dr. Hann, and adopted by himself (*Meteor. Zeitsch.*, 1874, and Smithsonian Report, 1877). M. H. Faye continues his articles on the "Accessory Phenomena of Cyclones." This number also contains a summary of a report by Mr. W. Ogilvie on his exploration of the Canadian Yukon, and the region between it and the Mackenzie, in 1887 and 1888, embracing some portions of country never before visited by a white man. He wintered in 1887 in lat. 64° 61′, long. 140° 54′. The maximum pressure in January reached 30·3 inches or 0·3 inch higher than the most trustworthy maximum isobars for that region. The mean minimum temperature in December was − 33°·6, and the absolute minimum in the same month − 55°·1. The mean temperature is not given. Drifting ice in the river commenced on October 21, the ice set on November 15, and on February 3 the thickness amounted to 48 inches. From the station on the Yukon to one on the Porcupine, lat. 65° 43′ long., 139° 43′, the following meteorological notes are given: lowest temperature in April, − 37°. The last time a minus reading was recorded was May 5, − 1°·8. Highest temperature in April, 40° on 30th; the highest in May, 55° on 7th. The report contains a series of notes on the opening and closing of the Mackenzie, on the duration of sunlight, and on the climate and capabilities of that region. Green clouds, a phenomenon apparently rare, were observed on the mornings of February 19 and 29 just before sunrise; at the same time there was a slight fall of minute ice-crystals.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 11.—"On Ellipsoidal Harmonics." By W. D. Niven, F.R.S.

In this paper some of the properties of these functions are

---

[1] "Memoranda of Field Experiments at Rothamsted, Herts, conducted by Sir John Lawes, Bart." 1890.

© 1890 Nature Publishing Group